Regenerating the Natural Longleaf Pine Forest

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Reprinted from the JOURNAL OF FORESTRY
Vol. 77, No. 9 September 1979

*ABSTRACT—Natural regeneration by the shelterwood system is a reliable, low-cost alternative for existing longleaf pine (*Pinus palustris *Mill.) forests. The system is well suited to the natural attributes and requirements of the species. It may be attractive to landowners wishing to retain a natural forest and avoid high costs of site preparation and planting. Seven successive regeneration steps are: (1) thin overstocked stands to about 70 square feet of basal area per acre; (2) about 5 years before the scheduled harvest reduce the stand to a basal area of 30 square feet per acre of best crop trees; (3) monitor seed crops through annual checks of flowers and conelets on sample trees; (4) prepare a seedbed when a good crop is forecast; (5) check regeneration areas for seedling stocking; (6) after an adequate seedling stand is established remove the overstory; (7) control hardwood competition and brown-spot as needed.*

Longleaf pine has always been recognized as a high-quality timber tree, better suited than other southern pines to the whole range of products—sawtimber, poles, piling, posts, plywood, pulpwood, and naval stores. Because of its desirable qualities, this species has been intensively exploited since colonial days. As a result, the vast longleaf forest, once estimated to cover up to 60 million acres from southern Virginia to eastern Texas (Wahlenberg 1946) has dwindled to less than 5 million acres. Most of the remaining longleaf forests are natural second-growth stands of harvest age. These stands, as they are clearcut, are usually replaced by other species.

Longleaf has the reputation of being a slow-growing species that is difficult to regenerate and is, thus, unable to compete economically with loblolly (*P. taeda* L.) and slash (*P. elliottii* var. *elliottii* Engelm.) pines. Yet longleaf has many desirable attributes that should weigh heavily in its favor. As well as being a versatile timber tree, it resists the most serious insects and diseases that attack slash and loblolly pines. It also withstands fire and can flourish under burning regimes that eliminate most other woody species (*fig. 1*).

Moreover, some evidence suggests that the species' reputation for slow growth may be more myth than reality. When survival is adequate, growth on many sites compares favorably with that of other pines. Natural stands on medium sites (site index of 70 to 80 feet at age 50 years) can produce 1.2 to 1.5 cords of mean annual increment per acre to age 30, with five-year periodic annual increments of 2 to 4 cords per acre between ages 20 and 30 (Farrar 1974).

Ecology

The longleaf pine forest is generally considered a subclimax type limited largely to areas that burn often and to poor sites supporting only a sparse cover of competing vegetation. The species was most common on the flat to rolling upland sites of the middle coastal plains of the Atlantic and Gulf Coast. Longleaf was also frequently associated with slash pine as an important component of flatwoods forests. On hilly sites of the upper Coastal Plain and in the mountains it occurs mainly on ridge tops and exposed south and southwest slopes where dry conditions favor frequent fires. Longleaf is also a pioneer species, given an adequate seed source, and invades abandoned fields and areas cleared by some catastrophic event like severe wildfire or blowdown.

Once established, longleaf pine perpetuates itself where fires occur frequently. Needle litter from overstory pines supports hot ground fires that limit encroachment of hardwoods and brush, providing conditions favorable for seedling establishment. In the open or under a light overstory, longleaf seedlings will tolerate surface fires. But under medium to dense overstories, seedlings often cannot survive the combination of slower growth caused by competition and hot surface fires fueled by abundant litter. Thus longleaf usually originates in openings or under light pine overstories where less intense fires keep hardwoods at low levels but do not seriously harm established longleaf seedlings.

In the past, apparently, longleaf stands matured and gradually thinned out as trees were felled by old age, lightning, insects, or disease. Growing space so released was rapidly occupied by seedlings. Patchy stands originating in this way are common in second-growth forests (*fig. 2*). Early logging sometimes simulated this process when stands were high-graded one or more times. Reducing the overstory in stages promoted establishment and survival of seedlings, which

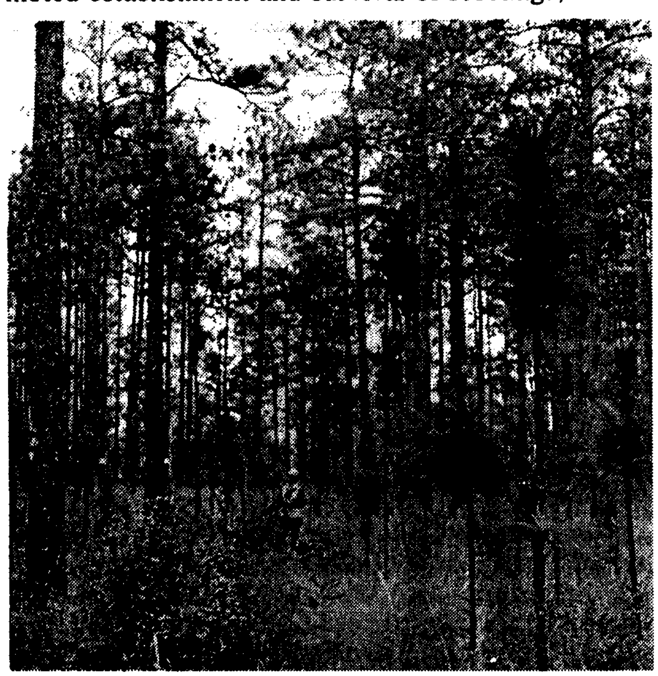

Figure 1. Four successive biennial spring fires have burned through this low-density longleaf stand. Longleaf pine regeneration has successfully survived and flourished under this regime.

Figure 2. Young longleaf pines filling in holes in a maturing second-growth stand. As older trees are gradually thinned out, the released growing space is occupied by younger trees. This process here is leading to a stand comprised of small even-aged patches and single trees. Periodic fires keep down hardwoods.

Figure 3. Longleaf shelterwood stand with a basal area of 30 square feet per acre of residual dominants. This density maximizes seed production and also produces high-quality volume growth during the regeneration period.

were released with the final clearcutting or catastrophic destruction of the old growth.

Natural Regeneration: A Reliable Alternative

Early observations of natural seedling establishment led to the hypothesis that some form of a shelterwood system might be most appropriate for this species (Croker 1956), because it most closely parallels examples of successful regeneration in nature. The approach is flexible and the system can be widely modified, perhaps even to the point where it grades into the single-tree or group-selection system.

Natural regeneration is a reliable, low-cost alternative for existing longleaf forests, and it should be particularly attractive to the forest landowner reluctant to make the heavy capital investment required by intensive site preparation and planting after clearcutting the old stand. Application of the system can be described in seven steps.

1. *If stand density exceeds 80 square feet of basal area per acre, begin with a preparatory cut.* This cut, a thinning from below, reduces stand density to 60 to 70 square feet per acre of the best trees. Residual hardwoods too large for control by fire are removed also. Preferably, no more than one-third of stand basal area is removed in a single cut. Residuals then expand their crowns and occupy released space with minimum loss in volume growth. Small-crowned trees in a dense stand cannot respond rapidly to release with either increased growth or cone production if the stand is suddenly reduced to, say, 30 square feet of basal area.

Ideally, a well-managed stand approaching harvest age in a sawlog rotation (usually about 60 years) will already have 60 to 80 square feet of basal area per acre. Hardwood and shrub cover should be light because of periodic burning during the rotation. Given these conditions, a preparatory cut is not necessary and the following steps are taken in sequence (Croker and Boyer 1975).

2. *About 5 years before the expected harvest date, make a seed cut, creating a shelterwood stand with a density of about 30 square feet per acre (fig. 3).* Trees reserved from cutting should be high-quality dominants with well-developed crowns, preferably those with some evidence of past cone bearing. Per-acre seed production peaks at stand densities between 30 and 40 square feet and falls off sharply above and below these densities. Seedling losses from logging increase with density of the clearcut stand (Maple 1977a): at 30 square feet or less, seedling mortality related to logging should remain below 50 percent.

A shelterwood stand is still dense enough to retard understory hardwoods, extending their vulnerability to fire. An added benefit is the high-quality volume growth on residual trees. Although the seed cut may reduce stand basal area by half, volume growth is reduced only about one-third. Mortality among overstory trees in shelterwood stands is low, averaging less than 1 percent annually, and some of it can be salvaged with the final harvest.

3. *Monitor prospective seed crops through annual checks of flowers and conelets on sample trees.* Seed crops of a size to regenerate the stand should be anticipated far enough in advance for seedbed preparation prior to cone opening. Within the regeneration area, select at least 45 trees for springtime counts of both flowers (next year's crop) and conelets (this year's crop). These counts are best made when both flowers and year-old conelets are most visible, that is, shortly before they are obscured by growth of new foliage (Croker 1971). As losses of female flowers during the first year are highly variable, these counts have marginal value for predicting successful crops, but they reliably predict failures. Conelet counts can pre-

ure 4. Stands regenerated by the shelterwood method on Escambia Experimental Forest in southern Alabama. The stand in the background is 20 years old; that in the foreground is shown 3 years after final overstory removal.

dict the size of the coming cone crop. If the regeneration area is burned within a year before seedfall, conelet counts will also predict the number of established seedlings.

4. When conelet counts indicate that an adequate seed crop is coming, prepare a seedbed. If shrubs and hardwoods were under control before the seed cut, only a prescribed burn is needed to remove accumulated litter and expose mineral soil. Burns can be made at any convenient time from conelet counts until mid-October, when seeds usually begin to fall. However, if small longleaf seedlings (less than 0.3 inch in rootcollar diameter) are already on the site, a cool winter burn will minimize fire losses among them. In this case, the need for a seedbed burn is based on flower counts that indicate a possible good cone crop the next year. If a growing-season burn is necessary, then probable losses of existing seedlings must be balanced against the number expected from the coming crop.

5. Check regeneration areas annually to determine number and distribution of established seedlings. Surveys are best made during the winter, when small grass-stage seedlings are most easily seen. The regeneration goal should be establishment of 6,000 or more seedlings per acre before the overstory is harvested. This number allows for losses to logging and provides enough surviving seedlings so that the superior 10 to 20 percent will provide the crop trees. The superior natural seedlings usually exhibit both resistance to brown-spot needle blight and rapid juvenile growth (Boyer 1972). Slower growing and diseased seedlings are expendable.

The stocking of quarter-milacre sample plots is a sensitive index for stands of 4,000 to 8,000 seedlings per acre. The relationship between quarter-milacre stocking levels and seedlings per acre has been established (Boyer 1977), and 6,000 seedlings per acre is equivalent to 63 percent of sample plots stocked with one or more seedlings. At this level, a minimum of 100 sample plots will provide estimates within 10 percentage points of actual stocking. If the regeneration area is not uniform in important site factors affecting seedling establishment, it should be stratified into relatively homogeneous units, and stocking determined separately for each. Because newly established seedlings face many hazards, final appraisal of regeneration success should be based on seedlings that have survived their first year.

6. Remove the overstory after a satisfactory stand of seedlings is established. If overstory density exceeds 40 square feet of basal area per acre, logging mortality may range up to 70 percent of the seedling stand. If the seedling stand is not dense enough to sustain such losses, it may be advisable to remove the overstory in two cuts rather than in one. Seedlings will survive overstory competition for a long time, so removal usually can be scheduled to suit management needs and market conditions. Preferably the overstory is taken off when seedlings are one or two years old, but almost any time before the dominants begin height growth appears satisfactory. Stemless, grass-stage seedlings are less vulnerable to logging injury than those in height growth and will often sprout from the rootcollar if top-killed.

Small seedlings need protection from fire, but once crop seedlings reach 0.3 inch or more in rootcollar diameter a preharvest burn may be prescribed if needed to control understory hardwoods.

7. After the overstory is removed, burn as needed for control of hardwood brush or the brown-spot needle blight. A brown-spot survey of crop seedlings (Croker 1967) will indicate if a burn is needed. The first fire must be delayed for at least two years after overstory removal, as the fuel load from logging slash plus residual litter might make the burn too hot for newly released seedlings. By the end of the second year after logging, seedling growth and decay of organic debris will have diminished the risk of damage considerably. According to some reports, spring burns not only kill hardwoods more efficiently than fires at other seasons, but are also a greater stimulus to seedling height growth (Maple 1977b, Grelen 1978). Longleaf seems to be one of the few woody species whose seedlings withstand a regime of periodic spring fires (*fig. 1*).

Examples

The shelterwood system outlined above has been successfully applied in studies and operational tests on a wide variety of sites and locations in the Atlantic and Gulf Coastal Plains from North Carolina to Louisiana and also in the mountain province of Alabama. Successful trials on the Escambia Experimental Forest, in southern Alabama, date back more than 20 years, and shelterwood regeneration is now a standard procedure there (*fig. 4*). A regeneration test in the Alabama mountains has a longleaf stand 16 years old from seed—13 years from overstory removal (*fig. 5*).

A total of 27 regeneration test areas have been established in a large-scale study, seven of these on the Escambia Experimental Forest. Twenty-two have been cut back to a shelterwood overstory for three or more years, and on 13 of these the overstory has been removed following successful regeneration. Five of the remaining nine are now stocked with 4,000 or more seedlings per acre. For these tests, the average time between the seed cut and establishment of 4,000 or more seedlings per acre was 3.5 years. Three test areas, however, were well stocked with seedlings before the seed cut was made. If these are excluded, average time between seed cut and establishment of a new stand was 4.5 years.

A major factor affecting time between the seed cut and seedling establishment is the occurrence of good seed crops (1,000 or more cones per acre). Of 18 test areas now satisfactorily stocked, half were regenerated in 1973. Four of five established test areas were regenerated by a good seed crop in 1967. Typical shelterwood stands on the Escambia Experimental Forest have good seed crops, on the average, in one year out of three. On all regional test areas, these good crops have occurred in one year out of five.

Figure 5. Natural regeneration of mountain longleaf, Talladega National Forest, 13 years after harvest of parent overstory. Background—had a seedbed burn 1 year ahead of seed fall; foreground—no seedbed burn.

In brief, results to date indicate that longleaf pine stands can be naturally regenerated at low cost and with a high probability of success if necessary cultural measures are properly timed and executed. Longleaf's habits and requirements make it uniquely adapted to a wide variety of management goals and silvicultural methods ranging from extensive even-aged stands to group or even single-tree selection. This, in combination with the many desirable attributes of longleaf pine, should win it a permanent and important role in the future of southern forestry. ■

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